

Aerospace Engineering, B.S.A.E.

Degrees Offered

- Bachelor of Science in Aerospace Engineering (B.S.A.E.)
- Dual Degree in Aerospace and Mechanical Engineering

Nature of the Program

Aerospace travel, space exploration, and flight of manned or unmanned vehicles continue to gain significance. Aerospace engineering is involved with the science and technology of advanced vehicles, including aircraft, rockets, missiles, and spacecraft. Although a specialized branch of engineering, it is also diverse. Aerospace technology has expanded to include design and development of earthbound vehicles such as ground-effect machines, hydrofoil ships, and high-speed rail-type systems.

The curriculum consists of a judicious combination of fundamentals, including mathematics and sciences, and practical laboratory experience which provides access to modern engineering tools. Aeronautical engineering subjects are to be the focus of the discipline along with significant exposure to space-related topics. Graduates will be able to critically analyze aerospace engineering problems and execute practical solutions. In addition to being able to function independently, it is expected that graduates will be able to function with effective written and oral communication within multidisciplinary teams and be prepared to address several issues such as environmental, social, and economic considerations, due to a thorough education in the humanities, social sciences, ethics, safety, and professionalism.

The aerospace engineering curriculum includes studies in the disciplines encountered in the design of aerospace vehicles, missiles, rockets, and spacecraft. Undergraduate students extensively study the basic principles of aerodynamics, solid mechanics and structures, stability and control, thermal sciences, and propulsion. The senior year includes a capstone flight vehicle design course providing an experiential learning opportunity.

Students are involved in both theoretical and experimental studies and trained to integrate knowledge with practical engineering design. With the breadth and depth of education in aerospace engineering, students become versatile engineers, competent to work in many areas. The curriculum may serve as a terminal degree program by incorporating design-oriented courses for technical electives or it may be used as a preparatory program for advanced study by the selection of science-oriented courses.

While the undergraduate curriculum is sufficiently broad to permit graduates to select from a wide variety of employment opportunities, it contains sufficient depth to prepare students to enter graduate school to pursue advanced degrees. As modern science and engineering become more complex, the desirability of graduate-level preparation is being recognized by most advanced industries and government agencies.

Students can simultaneously pursue B.S. degrees in both aerospace engineering and mechanical engineering by completing additional courses. Information on this 158 credit-hour, four-and-one-half-year option can be seen at the end of this department description.

Students who plan a career in medicine, dentistry, or related areas, but who desire an aerospace engineering degree before entering the appropriate professional school, may substitute eight hours (from a combination of biology and organic chemistry courses) for the required six hours of technical electives. This selection will help students satisfy admission requirements to the professional schools in the health sciences.

The aerospace engineering program at WVU is administered by the faculty of the Department of Mechanical and Aerospace Engineering. The Bachelor of Science in Aerospace Engineering program is accredited by the Engineering Accreditation Commission of ABET, <https://www.abet.org> (<https://www.abet.org/>).

Program Educational Objectives

It is expected that, within a few years of graduation (3 to 5 years), graduates will attain the following Program Educational Objectives (PEO's):

PEO-1. Proficiency in practicing one or more areas of aerospace engineering.

It is expected that after a few years of graduating (3 to 5 years), graduates will have consolidated professional proficiency as practitioners in at least one technical area of aerospace engineering, as reflected by the responsibilities and accomplishments of their professional practice.

PEO-2. Success in adapting to the demands of the workforce in the dynamic technological arena.

It is expected that, within a few years of graduation (3 to 5 years), graduates will have successfully adapted to the demands of the workforce in a dynamic technological arena through a professional practice that reflects high credentials or development of new technical skills and acumen for administrative functions.

PEO-3. Progress in their personal career development through professional service, continuing education and/or graduate studies.

It is expected that, within a few years of graduation (3 to 5 years), graduates will have made meaningful progress in their professional career, either by promotions to positions of higher responsibility with their employers, by participation in professional service activities, or by technical self-improvement through continuing education or graduate degree programs.

PEO-4. Meaningful involvement in a team that tangibly contributes to industry and/or society through the engineering discipline.

It is expected that, within a few years of graduation (3 to 5 years), graduates will have the experience of being or having been members in a team of professionals successfully making tangible technical contributions to industry or society through an engineering discipline.

Spring Semester Study Abroad Opportunity in Rome, Italy

PRIMARILY FOR JUNIOR YEAR ME AND AE UNDERGRADUATE STUDENTS

All MAE undergraduates are invited to consider spending the spring semester of their junior year studying abroad at the University of Rome Tor Vergata ("UTV", for short). This very successful program is taught fully in English at UTV to both Italian undergraduate engineering students and students from other countries all over the world. Through this program WVU students have the opportunity to earn credits towards their WVU BSME or dual BSME/BSAE degrees for a full semester of equivalent WVU engineering courses towards their degrees. Please see the following link for the UTV description of this program:

<https://engineering-sciences.uniroma2.it/course-structure/>

In order to ensure that, upon successfully passing the UTV class examinations, the credits earned at UTV will transfer back to WVU for the equivalent courses within the MAE degree programs, it is recommended that students should select from the following list of UTV courses only those courses that are regularly taught during their spring semester:

UTV also strongly recommends that WVU students register for Italian Language Class for Foreigners 2.

Additional courses taught during the UTV fall semester as listed above can also be completed by students who participate in this WVU-UTV student exchange program for their full junior year: e.g., Kinematics and Dynamics of Mechanisms (for WVU courses MAE 342 & MAE 495), Electrical Network Analysis (for WVU course EE 221), and Fluid Machinery (for WVU course MAE 495).

The UTV spring semester classes begin each year in mid-February, with classes ending near the end of June. Examinations are then given during the month of July. WVU students who participate in the WVU-UTV exchange program must pay their normal WVU tuition and fees for their study abroad semester, and are also responsible to cover all of their travel and living expenses while participating in the program. You must complete your transient form (studyabroad.wvu.edu) before your semester abroad. Check with your advisor before registering for courses to approve your course choices. This program is also part of the WVU Statler program to earn the Certificate of Global Competency; see the MAE Department program description in the current WVU Catalog for additional details of this Certificate Program.

WVU students must meet the relevant course prerequisites for the WVU course for which they wish to earn credit via a course taken at UTV. Also, because the UTV courses are only taught once a year, WVU students are encouraged to discuss with their academic advisors as early as possible the feasibility of delaying a course listed in the current WVU Catalog for the junior year fall semester in the Suggested Plan of Study for your major.

Study Abroad in the Summer

INDUSTRIAL OUTREACH PROGRAM IN MEXICO

PRIMARILY FOR SENIOR YEAR ME AND AE UNDERGRADUATE STUDENTS

Senior students in good standing in the MAE Department have the opportunity to participate in the Industrial Outreach Program in Mexico (IOPM) during the summer of each year (June and July) to earn a total of 9 credits (described below) toward their BS degree requirements in the BSAE or BSME Degree; this program is also available for other engineering majors. In this program, students are teamed up with Mexican students from local universities and conduct meaningful engineering projects in industrial sites, working full time under the guidance and supervision of practicing industrial engineers and faculty members. The duration of the program is 8 weeks.

The Objectives of this Program are:

1. To add value to student's education through international experiential learning.
2. To solve meaningful engineering problems of value to industry.
3. To bridge the gap between academia and industry to benefit both.

Practical engineering problems from well-established companies in Mexico are presented to each team, with specific objectives and technical deliverables to be attained during the 8 week duration of the program. A final report and a final presentation are delivered at the end to personnel from industry and faculty members. A poster session is conducted at the closing of the program.

The main venue of this program is in Queretaro City and surroundings. Students are placed in home-stay with local families who provide clean, safe, healthy and friendly environment to students providing a full cultural and professional immersion. Weekends are used for field trips and cultural

sightseeing. Fundamental knowledge of Spanish language is recommended but is not essential, as all the Mexican students and engineering liaisons are required to speak English.

Courses with credit:

- MAE 471 Principles of Engineering Design (3 cr) – Capstone Design Course
- MAE 472 Engineering System Design (3 cr) – Project Technical Elective
- FCLT 260 Cultures of Mexico (3 cr) – GEF 7 Global Studies and Diversity

This is a summer faculty led program administered by WVU Office of International Programs (<https://studyabroad.wvu.edu/>) and provides eligibility for the Statler College Certificate of Global Competency.

General Education Foundations

Please use this link to view a list of courses that meet each GEF requirement. (<http://registrar.wvu.edu/gef/>)

NOTE: Some major requirements will fulfill specific GEF requirements. Please see the curriculum requirements listed below for details on which GEFs you will need to select.

Code	Title	Hours
General Education Foundations		
F1 - Composition & Rhetoric		3-6
ENGL 101 & ENGL 102 or ENGL 103	Introduction to Composition and Rhetoric and Composition, Rhetoric, and Research Accelerated Academic Writing	
F2A/F2B - Science & Technology		4-6
F3 - Math & Quantitative Reasoning		3-4
F4 - Society & Connections		3
F5 - Human Inquiry & the Past		3
F6 - The Arts & Creativity		3
F7 - Global Studies & Diversity		3
F8 - Focus (may be satisfied by completion of a minor, double major, or dual degree)		9
Total Hours		31-37

Please note that not all of the GEF courses are offered at all campuses. Students should consult with their advisor or academic department regarding the GEF course offerings available at their campus.

Degree Requirements

Students must meet the following criteria to qualify for a Bachelor of Science in Aerospace Engineering:

- Complete a minimum of 129 credit hours
- Satisfy WVU's undergraduate degree requirements
- Satisfy Statler College's undergraduate degree requirements (<http://catalog.wvu.edu/undergraduate/collegeofengineeringandmineralresources/#policies>)
- Complete all courses listed in the curriculum requirements with the required minimum grades
- Attain an overall grade point average of 2.00 or better
- Attain a WVU grade point average of 2.00 or better
- Attain a Statler grade point average of 2.00 or better
- A maximum of one math or science course with a grade of D+, D, or D- may apply toward a Statler College degree
- Complete a survey regarding their academic and professional experiences at WVU, as well as post-graduation job placement or continuing education plans

The Statler GPA is computed based on all work taken at WVU with a subject code within Statler College (BIOM, BMEG, CE, CHE, CPE, CS, CSEE, CYBE, EE, ENGR, ENVE, ETEC, IENG, IH&S, MAE, MINE, PDA, PNGE, SAFM, SENG) excluding ENGR 140, ENGR 150, and CS 101. The WVU GPA is computed based on all work taken at West Virginia University. The Overall GPA is computed based on all work taken at West Virginia University and transfer work.

Curriculum Requirements

Code	Title	Hours
University Requirements		16
Fundamentals of Engineering Requirements		5
Math and Science Requirements		28
Aerospace Engineering Program Requirements		80
Total Hours		129

University Requirements

Code	Title	Hours
General Education Foundations (GEF) 1, 2, 3, 4, 5, 6, 7, and 8 (31-37 Credits)		
Outstanding GEF Requirements 1, 5, 6, and 7		15
ENGR 191	First-Year Seminar	1
Total Hours		16

Fundamentals of Engineering Requirements

Code	Title	Hours
A minimum grade of C- is required in all Fundamentals of Engineering courses.		
ENGR 101	Engineering Problem Solving 1	2
Engineering Problem Solving (Select one of the following):		3
CHE 102	Introduction to Chemical Engineering	
ENGR 102	Engineering Problem-Solving 2	
ENGR 103	Introduction to Nanotechnology Design	
MAE 102	Introduction to Mechanical and Aerospace Engineering Design	
Total Hours		5

Math and Science Requirements

Code	Title	Hours
A minimum grade of C- is required in all Math and Science courses.		
CHEM 115 & 115L	Fundamentals of Chemistry 1 and Fundamentals of Chemistry 1 Laboratory (GEF 2B)	4
Calculus I: (GEF 3)		4
MATH 155	Calculus 1	
MATH 153 & MATH 154	Calculus 1a with Precalculus and Calculus 1b with Precalculus	
MATH 156	Calculus 2 (GEF 8)	4
MATH 251	Multivariable Calculus	4
MATH 261	Elementary Differential Equations	4
PHYS 111 & 111L	General Physics 1 and General Physics 1 Laboratory (GEF 8)	4
PHYS 112 & 112L	General Physics 2 and General Physics 2 Laboratory (GEF 8)	4
Total Hours		28

Aerospace Engineering Program Requirements

Code	Title	Hours
ECON 201	Principles of Microeconomics (GEF 4)	3
EE 221	Introduction to Electrical Engineering	3
EE 221L	Introduction to Electrical Engineering Laboratory	1
MAE 202	Sophomore Seminar	1
MAE 212L	Introduction to Computer Aided Design	1

MAE 215	Intro to Aerospace Engineering	3
MAE 216L	Intermediate Engineering Computation	1
MAE 241	Statics	3
MAE 242	Dynamics	3
MAE 243	Mechanics of Materials	3
MAE 244L	Dynamics and Strength Laboratory	1
MAE 316	Analysis-Engineering Systems	3
MAE 320	Thermodynamics	3
MAE 335	Incompressible Aerodynamics	3
MAE 336	Compressible Aerodynamics	3
MAE 345	Aerospace Structures	3
MAE 353	Intermediate Mechanics of Materials	3
MAE 423	Heat Transfer	3
MAE 434 & 434L	Experimental Aerodynamics and Experimental Aerodynamics Laboratory	3
MAE 456 & 456L	Computer-Aided Design and Finite Element Analysis and Computer-Aided Design and Finite Element Analysis Laboratory	3
MAE 460	Automatic Controls	3
MAE 476	Space Flight and Systems	3
Area of Emphasis		12
Aeronautical Engineering		
Astronautical Engineering		
Technical Electives (see list for details below)		12
Total Hours		80

Aerospace Engineering Technical Electives

Code	Title	Hours
Students are limited to a total of 3 hours under MAE 491, MAE 495 and/or MAE 496		
Students may substitute one technical elective from the substitute technical electives		
Students may substitute two technical electives from the pre medical technical electives		
MAE 312	Introduction to Mechanical Design	3
MAE 361	Introduction to Unmanned Aerial Systems	3
MAE 365	Flight Dynamics	3
MAE 415S & MAE 417S	Balloon Satellite Project 1 and Balloon Satellite Project 2	3
MAE 426	Flight Vehicle Propulsion	3
MAE 430S or MAE 431S	Microgravity Research 1 Microgravity Research 2	3
MAE 432	Engineering Acoustics	3
MAE 433	Computational Fluid Dynamics	3
MAE 437	Vertical/Short Takeoff and Landing Aerodynamics	3
MAE 446	Mechanics of Composite Materials	3
MAE 447	Aeroelasticity	3
MAE 457	UAV Path Planning and Trajectory Tracking	3
MAE 465	Flight Mechanics 2	3
MAE 466	Spacecraft Dynamics	3
MAE 467	Introduction to Flight Simulation	3
MAE 469	UAV Guidance, Navigation & Control	3
MAE 474S	UAV Design/Build/Fly Comp	3
MAE 475S	Flight Vehicle Design-Capstone	3
MAE 478	Guided Missile Systems	3
MAE 482	Flight Simulation for Aircraft Safety	3

MAE 484	Spacecraft Propulsion	3
MAE 485S	Flight Vehicle Design 2	3
MAE 486S	Spacecraft Design 1	3
MAE 487S	Spacecraft Design 2	3
Any MAE 493 Except Technical Entrepreneurship and Additive Manufacturing		
MAE 491	Professional Field Experience	3
MAE 495	Independent Study	3
MAE 496	Senior Thesis	3
Any MAE 500 Level Course		
BMEG 340	Biomechanics	4

Substitute Technical Electives

Aerospace Engineering students may take one of the following courses with prior approval from the AE curriculum chair. Students may only count one of the substitute courses toward their degree, and must complete other elective requirements from the Technical Electives list.

Code	Title	Hours
CHE 366	Materials Science	3
CHE 463	Polymer Composites Processing	3
CS 430	Advanced Software Engineering	3
CS 453	Data and Computer Communications	3
EE 327	Signals and Systems 1	3
EE 335 & 335L	Electromechanical Energy Conversion and Systems and Electromechanical Energy Conversion and Systems Laboratory	4
EE 345	Engineering Electromagnetics	3
EE 463	Digital Signal Processing Fundamentals	3
MATH 441	Applied Linear Algebra	3
MATH 456	Complex Variables	3
MATH 465	Partial Differential Equations	3
PHYS 314	Introductory Modern Physics	4
PHYS 332	Theoretical Mechanics 2	3
PHYS 451	Introductory Quantum Mechanics	3

Pre-Medical Technical Electives

Students who plan a career in medicine, dentistry, or related areas may substitute eight hours from the list of courses below for six hours of technical electives.

Code	Title	Hours
Choose two of the following:		
CHEM 233 & 233L	Organic Chemistry 1 and Organic Chemistry 1 Laboratory	4
CHEM 234 & 234L	Organic Chemistry 2 and Organic Chemistry 2 Laboratory	4
BIOL 115 & 115L	Principles of Biology and Principles of Biology Laboratory	4
BIOL 117 & 117L	Introductory Physiology and Introductory Physiology Laboratory	4

Suggested Plan of Study

First Year

Fall	Hours	Spring	Hours
CHEM 115 & 115L		4 MAE 102	3
ENGL 101 (GEF 1)		3 MATH 156 (GEF 8)	4

ENGR 101		2 PHYS 111 & 111L (GEF 8)	4
ENGR 191		1 GEF Elective 6	3
MATH 155 (GEF 3)		4 GEF Elective 7	3
GEF Elective 5		3	
		17	17
Second Year			
Fall	Hours	Spring	Hours
MAE 202 [*]		1 ENGL 102 (GEF 1)	3
MAE 212L		1 MAE 242	3
MAE 215		3 MAE 243	3
MAE 216L		1 MAE 244L	1
MAE 241		3 MATH 261	4
MATH 251 (GEF 8)		4	
PHYS 112 & 112L		4	
		17	14
Third Year			
Fall	Hours	Spring	Hours
ECON 201		3 EE 221 & 221L	4
MAE 316		3 MAE 336 [*]	3
MAE 320		3 MAE 345 [*]	3
MAE 335 [*]		3 MAE 476	3
MAE 353		3 AOE Course	3
		15	16
Fourth Year			
Fall	Hours	Spring	Hours
MAE 434 & 434L [*]		3 MAE 423	3
MAE 456 & 456L		3 MAE 460	3
Technical Electives		6 AOE Course	3
AOE Courses		6 Technical Electives	6
		18	15

Total credit hours: 129

Areas of Emphasis Offered:

- Astronautical Engineering (p. 7)
- Aeronautical Engineering (p. 8)
- Unmanned Aerial Systems (p. 8)

AREA OF EMPHASIS IN ASTRONAUTICAL ENGINEERING

Code	Title	Hours
MAE 466	Spacecraft Dynamics	3
MAE 484	Spacecraft Propulsion	3
MAE 486S	Spacecraft Design 1	3
MAE 487S	Spacecraft Design 2	3
Total Hours		12

AREA OF EMPHASIS IN AERONAUTICAL ENGINEERING

Code	Title	Hours
MAE 365	Flight Dynamics	3
MAE 426	Flight Vehicle Propulsion	3
MAE 475S	Flight Vehicle Design-Capstone	3
MAE 485S	Flight Vehicle Design 2	3
Total Hours		12

AREA OF EMPHASIS IN UNMANNED AERIAL SYSTEMS

Code	Title	Hours
Select three of the following:		9
MAE 361	Introduction to Unmanned Aerial Systems	
MAE 457	UAV Path Planning and Trajectory Tracking	
MAE 469	UAV Guidance, Navigation & Control	
MAE 474S	UAV Design/Build/Fly Comp *	
Select one of the following:		3
CS 453	Data and Computer Communications	
EE 327	Signals and Systems 1	
EE 463	Digital Signal Processing Fundamentals	
MAE 361	Introduction to Unmanned Aerial Systems	
MAE 446	Mechanics of Composite Materials	
MAE 457	UAV Path Planning and Trajectory Tracking	
MAE 469	UAV Guidance, Navigation & Control	
MAE 478	Guided Missile Systems	
MATH 441	Applied Linear Algebra	
Total Hours		12

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Maximum of 3 credit hours of MAE 474 or MAE 474S can count toward AOE

Student Outcomes

Upon graduation, all Bachelor of Science in Aerospace Engineering students will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The primary learning goal of the BSAE program is to implement state-of-the-art instructional materials, methods and technologies in order to prepare engineers who are highly proficient in their field of specialty and ready to contribute to the well-being of society through competent practice of the engineering profession, leading to economic development and innovative technological advancements.

The graduates of the BSAE program are well prepared to engage in the long-life pursuit of successful engineering careers by quickly adapting to the changing demands of the workforce in a dynamic global environment, by enhancing continuously their professional abilities or skills, and by contributing effectively in multidisciplinary teams to the advancement of existing or anticipated industrial, economical and societal needs.